Autumn 2018 *Issue 4*

Why & How?

The Primary Science Teaching Trust Newsletter

Supporting excellent teaching and learning in primary science

Free to access for all

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Common Misconceptions

Science in Stories – Can Science and Fiction coexist?

Cleaning water using a molecular sieve!

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Why & How? is the brand name of the Primary Science Teaching Trust

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Welcome

Welcome to Why & How? – the Primary Science Teaching Trust's termly newsletter. As we celebrate its first birthday we would like to thank everyone for all the helpful and constructive feedback we have had over the last year. We are delighted that it has been so well received. Please do continue to keep us posted about what you find most useful and interesting in our newsletter, and please do keep sharing it with anyone else who would like to receive practical classroom support, news and PSTT updates.

The **news** pages celebrate the launch of our renewed collaboration with the University of Hertfordshire to ensure the continued delivery and development of PSQM. We highlight our forthcoming international Primary Science Education Conference (PSEC), including details of our new addition to this event, the PSTT Children's Conference at PSEC. Don't miss the details of an exciting portrait competition being held by the Linnean Society. The deadline is soon, so your young artists will need to get cracking... See also the fantastic benefits of joining (free!) the Royal Society's Schools' Network.

Our feature on how to deal with children's **common misconceptions** is a bit different this time. Written by PSTT College Fellow Jules Pottle, it explores the extent to which reading fiction might generate or reinforce misconceptions in science. Jules draws on her extensive experience of using stories in science to provide a thought provoking piece as well as some sound words of advice. More about stories and science can be found in our **project update** section, where Sally Howard shares explores the role of stories in developing scientific thinking and enquiry.

Many of our readers may have been involved in some way in our project 'Chain Reaction' or come across it at conference workshops. Our exciting **Why and How Challenge** in this issue comes from the resource pack – if you like it and want more, the whole pack is free to download **here**.

We suggest you introduce the challenge to your children by starting with this issue's **picture as a stimulus for talk**. Based on a chain reaction, the picture provides a starting point for discussing causality as well as an opportunity to explore concepts relating to forces, levers and pulleys.

Please do share this (and all our free resources) with your colleagues.

> *"Chain reaction is adaptable, all-embracing and just fantastic!"*
>
> *project teacher*

Our summer **Free Resources from PSTT's own collections** is a Teachers' Project Pack for carrying out a climate change based project in school. We encourage you to register to take part in this fabulous opportunity and also to enter our photo competition – see details on the news pages. This could involve all your children in trying to capture on camera what science looks like in your school. Choose one image send in to us as your school's entry for a chance to win some fabulous prizes. First prize, kindly donated by TTS, is a collection of science resources worth over £350.

The process of getting fresh water from sea water cheaply and easily has long posed a challenge for scientists. But in an exciting recent development, scientists at the University of Manchester show that there may be a solution. In **'I bet you didn't know'** PSTT's CEO Dudley Shallcross describes how graphene (a form of carbon similar to graphite found in pencils) can be formed to behave like a sieve and extract the salt from salt water. The ideas summarised are linked to concepts encountered in primary science – changes of state, dissolving and separating materials – providing a helpful stimulus to practical investigation in the classroom.

This issue of Why and How? includes another **College Snapshot**. Six of our Primary Science Teacher College Fellows from across the UK share some quick thoughts and suggestions to support teaching and learning primary science.

Click to go back to contents

Our **project update** includes details of our the latest addition to PSTT's collection of resources, Science In My Pocket. This fantastic support is a set of structured science activities for teaching assistants to use with children needing emotional and behavioural support. Much awaited, it will soon be available to buy on our website. If you would like to be notified when it is available, please join our **mailing list**.

We draw your attention in our **research update** to two papers published in the most recent issue of the Journal of Emergent Science. Isabel Hopwood-Stevens outlines her analysis of how teachers' assessment practices in primary science are influenced by their role in school and their length of teaching experience. PSTT Fellow Clarysly Deller gives us some interesting insights about the role of drama in teaching and learning in science in the primary school.

Please have a look at our **key dates** page for reminders of what is on the horizon for primary science. Note our Primary Science Education Conference (PSEC) due to take place in Edinburgh in June 2019 and the closing date for applying for a teacher bursary to attend.

We invite you to share this newsletter with anyone you know who has an interest in primary science, and please do get in touch with us about what you like about our newsletter and what you would like to see in it. Please send your feedback and suggestions to us at **newsletter@pstt.org.uk**

Prof. Dudley Shallcross
CEO

Ali Eley
Academic Director

Dr. Sophie Franklin
Cluster Director

Sue Martin
Programme Director

News

News from the Linnean Society – a competition to create a portrait of Carl Linnaeus

The Linnean Society have an exciting opportunity for children aged 8-11 to create a 21st Century portrait of Carl Linnaeus to be hung in their historic Meeting Room while the original goes away for conservation works.

Carl Linnaeus was a world-famous biologist, a pioneer of classification, who came up with the naming system for all living things. He is mentioned specifically in the Year 6 curriculum and his work is discussed in Year 4.

This Competition is unique and will allow the winner to become a part of history by showcasing their artwork in a world-famous venue. It was at a Meeting of the Linnean Society that Darwin and Wallace's 'Theory of Evolution by Natural Selection' was presented for the first time!

They are looking for a special piece of art that captures the essence of Linnaeus (**watch their videos** and **read more about him** to inspire your art). The end product must be flat, in a standard paper size (minimum A4) and portrait (i.e. not landscape). You can be as inventive as you like – digital art, collages, drawings, paintings... anything! You could even take a photo of a 3D object and enter that, although they cannot accept video format.

For more information, visit:

www.linnean.org/newportrait

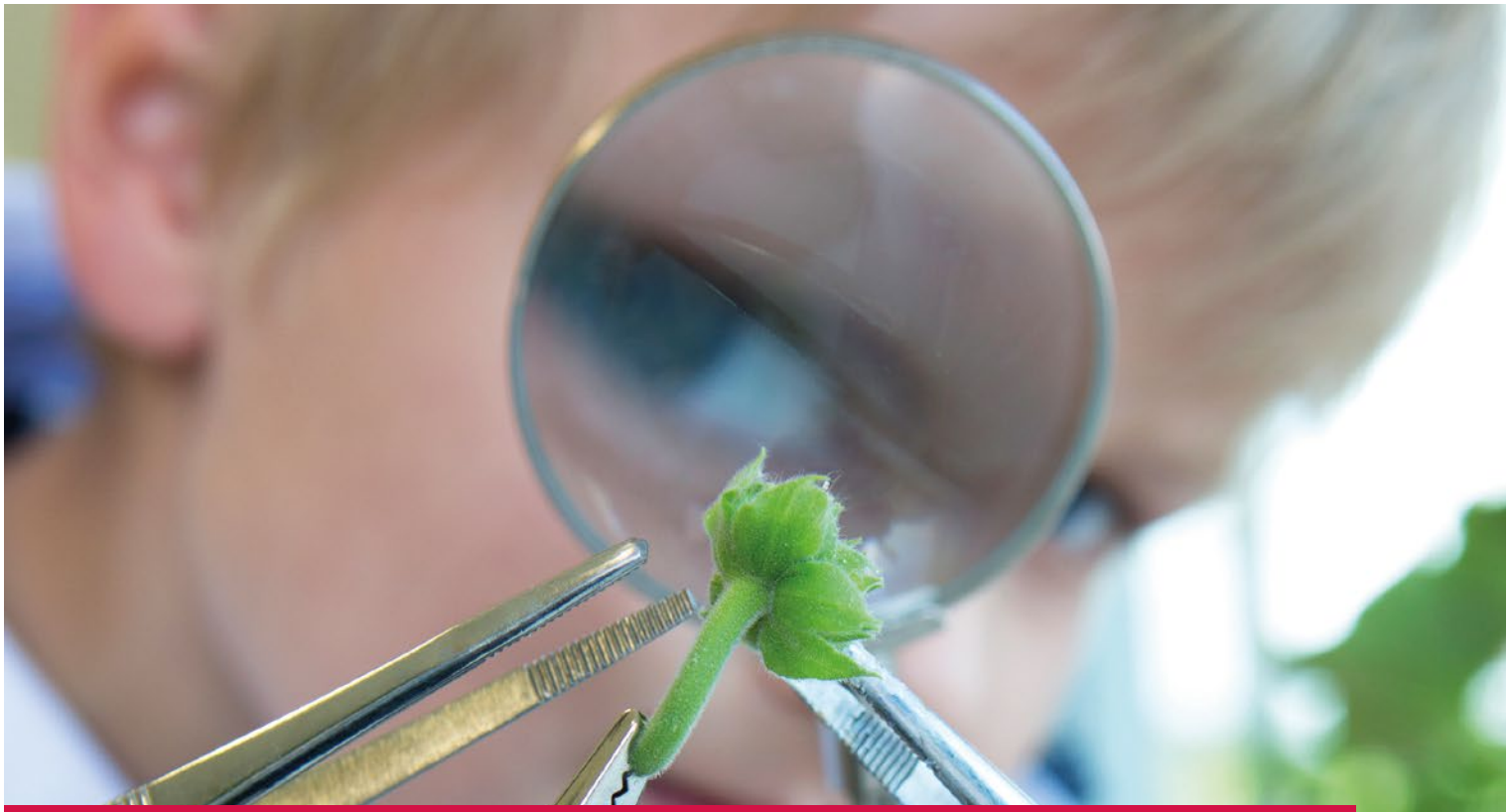
Royal Society Schools Network

We are delighted that two PSTT College Fellows, Paul Tyler and Sarah Eames, were awarded Royal Society Partnership Grants in the last funding round for their projects based in Mearns Primary School (Scotland) and Sandfield Close Primary School (Leicester).

Paul's project, which is also part-funded by the PSTT, is providing Mearn's Primary children with an opportunity to collect data on the atmospheric conditions above Scotland, through the deployment of a balloon carrying a variety of sensors (that they will program) and their own experiments. They will use weather data and software to forecast the balloon's likely movement to determine launch and retrieval sites. Further collaboration with the University of Bristol and PSTT CEO, Professor Dudley Shallcross, will enable the children to gain an even greater insight into atmospheric chemistry and conditions around the planet.

In Sarah's project, 'How many stars in the sky?' Sandfield Close Primary will be working with the University of Leicester to create lessons and experiences for Year 5 that will range from the microscopic to the vast wonders of the universe. Promoting wonder in the world around them, experiences will include a visit to the University's Physics Department and the Department of Molecular Cell Biology, a space dome will visit the school and a space camp sleepover will enable the children to look at the stars with members of Leicester's Astronomical Society. Children will use dataloggers and consider the meaning of the values given to temperature, light and sound.

The PSTT encourages all primary schools to join the Royal Society's Schools Network. Joining the network is completely free and all those within the network will receive a regular email newsletter highlighting support, events and resources for those teaching science, mathematics and computing to ages 5 to 18.



Be part of the Royal Society Schools Network and

Help research come alive in your classroom

By signing up to the Royal Society Schools Network you will have first-hand access to the latest opportunities and resources available for use in the classroom. Whether it is accessing funding opportunities via our Partnership Grants Scheme, accessing funded CPD, or using the Brian Cox School Experiments, the Royal Society Education Outreach team are committed to supporting teachers to undertake experimental work and problem solving activities across the STEM subjects.

Brian Cox School Experiments

A series of six simple experiments covering subjects from clean water to melting chocolate. Each experiment comes with resources and four short videos to support the teacher through set-up, the scientific method and health and safety. One of the videos shows the real world context of the science being investigated – a great way to get your pupils enthused.

To obtain a free copy of all 24 videos and related resources, please email your contact details to **education@royalsociety.org**

Partnership Grants Scheme

Funding of up to £3,000 is available to enable pupils across all Key Stages to carry out investigative projects in all STEM subjects. The funding, which is used to purchase equipment not normally found in UK schools, must be applied for in partnership with a STEM professional (from research or industry).

To find more information about the scheme, visit: **royalsociety.org/partnership**

Applications for 2019 open in February.

THE ROYAL SOCIETY

For more information about the Royal Society Schools Network please visit: **royalsociety.org/schools-network** or contact the team at **education@royalsociety.org**

PSTT/TTS Photo Competition – Win a Science ICT Collection worth over £350!

What does science look like in your school?

All UK primary schools (educating children from 4-11 years) are invited to submit a captioned photo for a chance to win this amazing Science ICT collection worth over £350 from TTS. Runner Up prizes include copies of PSTT resources I Can Explain, Titanic and Science Trails.

Let's get creative! Pupils might photograph an activity, a place, a reaction, or anything at all that they feel best represents 'Science At Our School'.

Why not organise a competition in your school and select the winner as your school's entry? We have participation certificates to download and award to your pupils.

The best entries will be displayed in a gallery at our international Primary Science Conference 2019.

Upload your school's entry here: **pstt.org.uk/what-we-do/news** ...

Full competition details, downloadable certificates, terms and conditions are on our website.

Closing date for entries: 14th December 2018

Primary Science Teaching Trust and the University of Hertfordshire: new collaboration

The Primary Science Teaching Trust is delighted to announce the start of a new collaboration with the University of Hertfordshire to support the continued delivery and development of the Primary Science Quality Mark. We are proud of our association with this highly successful award programme which celebrates teaching and learning of science in primary schools and offers outstanding development for science subject leaders. The new collaboration was launched at the annual PSQM Hub Leaders' conference.

Ian Campbell, The Vice-Chancellor of UH, and Dudley Shallcross, CEO of PSTT

INTERNATIONAL PSEC Primary Science Education Conference

Outstanding Professional Development for all Primary Science Educators

6 – 8 June 2019

Edinburgh International Conference Centre (EICC)

www.primaryscienceconference.org

Don't miss out on this event! The response to our call for programme proposals was fantastic – we were oversubscribed by more than 50%. The programme we have put together is high quality, wdiverse and exciting – click here to see our programme preview.

Bursary support for teachers to attend PSEC

We are very fortunate that several organisations have generously donated funding for bursaries to enable teachers to come to our Primary Science Education Conference 2019.

Bursaries are worth up to £1,000 and can be used to cover:

A three day conference ticket

Hotel accommodation for the duration of the conference (two nights)

Return travel to the conference venue

Two days of supply cover

One ticket to a PSTT CPD follow up event after the conference (Ts&Cs apply and expenses for this are not covered)

How to apply

The bursary application process is now open.

To be eligible to apply for a bursary, you must be a teacher who is employed in an infant, junior or primary school in the UK. You must have responsibility for the teaching of some science in your school although you do not need to be a science specialist. It is preferable, but not essential, that you are the subject leader for science.

The form is available to download **here**. Please note that it must be completed in full by the applicant, apart from section D, which must be completed by the headteacher or deputy headteacher from the applicant's school.

The deadline for applications is 5pm on 14th December 2018.

Terms and Conditions apply. Before making an application, please read carefully section 9 of the full Ts&Cs which can be found **here**.

COMMON MISCONCEPTIONS

Can Science and Fiction coexist?

Jules Pottle, PSTT College Fellow, explores how reading fiction might generate or reinforce misconceptions in science

sciencethroughstory@gmail.com

Once, in ancient Greece, there was an inventor, called Daedalus, who worked for a king. He created an impregnable maze to imprison a fearsome beast – a minotaur – a creature who was half man, half bull. When it was finished, the king, fearing this inventor would give away the secrets of this maze, had poor Daedalus and his son, Icarus, imprisoned in a tower. But Daedalus was a clever man. He devised a means of escape. He lured birds with his food and used the feathers and candle wax to create wings to fly away. Icarus was delighted by his wings and loved flying around. He took off, flying higher and higher. Despite his father's warnings, he flew up towards the sun. The wax melted and Icarus fell into the sea and was drowned.

Stories are there to help us to learn: our brains are hardwired to receive information in the form of a story. The Greeks knew that stories are a very powerful educational tool and this story clearly warns us of the folly of showing off and not heeding the warnings of a wise father. But what does this story teach us about science?

- *Wax melts when it is heated – true!*
- *The sun is hot – true!*
- *High in the sky, it is hot*
- *The relatively tiny pectoral muscles of a human are sufficient to beat wings which will lift the relatively huge weight of a man into the sky*

Not all these of these statements are true. Maybe the Greeks didn't know that it is cold when you reach high altitudes (unlikely as there are mountains in Greece which would have been snowy) or that bird skeletons are very light as they are largely hollow (again, unlikely as they would have eaten birds). Or maybe stories don't have to be completely true: they are born of imagination and anything we can imagine can happen in a story.

However, children pick up all kinds of information from stories to help them understand the world and sometimes this might be misinformation in terms of science. Thus, a false model of how something works may be constructed in the mind of a child, as a result of the story.

My son, until the age of four, bewildered us all by insisting on calling traffic cones 'watermelons'. It was only when I revisited 'The Very Hungry Caterpillar' with his younger sister that I saw where he had picked up this idea. Check out the centre page. The slice of watermelon is an orange triangular shape, with white stripy bits and a green line for the base! It looks very much like a traffic cone. It happens: children form strong ideas from something they have seen or heard in a story and those ideas can be wrong, leading to misconceptions.

But does that mean we shouldn't read scientifically incorrect stories to our children in case they pick up a scientific misconception? Or that we should point out the errors? Should we pause in our reading of the story to correct the science?

In order to answer this question, I think we need to see the issue from different points of view.

Firstly, as a storyteller, you don't always need to join all the dots. A story can move on without explaining how or why something happens and it doesn't seem to matter in the process of enjoying the story. We are imaginative beings and can visualise a bear making a rocket from cardboard boxes and taking off on a journey to the moon. We go with the story and imagine the bear's excitement or the view from the porthole window. We don't stop to think about how a bear, with no opposable thumb, cut a hole in the cardboard. This is how storytelling works. We imagine the possible and the impossible with equal ease.

Furthermore, as an actor telling a story in a play, we actually require the audience to suspend its disbelief and engage in fantasy. They can see that the people on stage are actors and that they are not really magic, or flying, or dead but they choose to be swept along in the story, imagining every detail. Clinging too hard to reality will destroy the fantasy.

However, as a science teacher, I do feel uneasy when I tell the story of Icarus and say he flew higher and higher and closer to the sun and the wax began to melt. In my head, I'm thinking, "How far did this man fly? How did he manage to get so close to the sun in the three minutes before he lost consciousness due to lack of oxygen?" I have also seen pictures where impossible things are drawn and sometimes I wonder if the artist has a misconception that needs tackling. For example, I have often seen water vapour, which is invisible, depicted as a cloud of visible liquid water droplets. If we can see the water then it is no longer a water vapour gas - it is a liquid in tiny droplets. But how can an artist draw something that is invisible? Thankfully, many authors are very careful to research the science involved in their stories and avoid writing (or drawing) incorrect science but too much focus on explaining it correctly can stop the flow of the narrative and make it clunky. There's a fine balance to hit.

Lastly, as a writer of science books for the non-specialist teacher, I know how important it is to not overcomplicate the science. It is really hard, however, to simplify the science without it becoming sort of incorrect by generalising or analogising. So, it is not easy to weave in a quick explanation of a scientific idea into a story without noticeably changing the mode of the writing from narrative fiction to a non-fiction explanation text. The science may have to be glossed over or explained in very basic terms to make it fit naturally into the narrative.

So how do we deal with these conflicting views?

The way I have dealt with it is to tell the story as it is written, faults and all. Then I tackle age appropriate misconceptions afterwards. After telling the story of Icarus, we discuss what it is really like when you fly in an aeroplane/go up a mountain and note that it is, in fact, very cold. Then, we discuss how far away the sun is and how close Icarus could have flown. If the children are aged eight and over, they can often spot these misconceptions for themselves. My experience is that, before the age of seven, most children don't have much concept of the very large, the very small, the very far away or the far, far back in time. Space, and the size of it, blows their minds in Year 3 and many of them still can't imagine anything that big, even after we've studied it and modelled it. So, if a picture book for five year olds suggests that you would pass the stars on the way to the moon, for example, explaining that stars are really far away whereas comparatively the moon is much closer, to a small child, is probably of limited value. They can't really picture either distance in their heads.

My school is full of very scientific children who know some highly technical words like atom, proton, dark matter etc at the age of five or six. They have been to see laboratories and science exhibitions or a parent's workplace. Do I believe that they really understand these big concepts just because they can say the words? No. But maybe they'll be a step ahead in finding out what they mean when their brains are ready for that information. In the same way, some concepts are just too big to tackle with small people, even if they appear in a book aimed at them but they can get to know the words and be ready to understand them when they're older.

So, I think misconceptions in fiction are inherent. To be imaginative we need to be able to ignore what is actually possible and visualise impossible things as reality. That is the nature of fantasy and playful writing for children. We cannot avoid the possibility of children picking up misconceptions without losing something that is fundamentally human. Nor can we insist that every picture book ever written is edited by a scientist. But I do think it is worth tackling any incorrect science in the story if the child is old enough to understand that particular science concept. So, celebrate the story. Fly with Icarus! And when the story is over, take the opportunity to explore the scientific conundrums it generates.

FREE RESOURCES

Pictures for talk in primary science

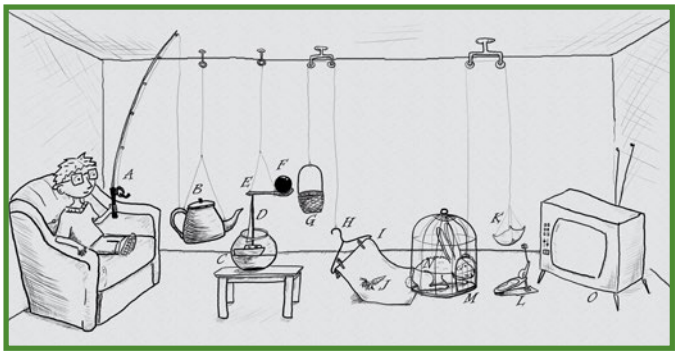
A picture can be a very good stimulus for children to engage in effective talk in science.

Using pictures is an inclusive approach that facilitates high levels of participation. Pictures can also be used as a starting point for inquiry. The discussions the children have will generate questions that they want to investigate. **A picture can be a very good stimulus for children to engage in effective talk in science.**

Asking the children carefully chosen questions about the picture will support them with learning to:

- *construct explanations and link their ideas with evidence*
- *make confident challenges to the ideas of others*
- *explore scientific terminology and use it with genuine understanding*

Pictures for talk in science activities are designed to be very open ended and usable with any age of children. The activities can be done as a quick ten minute starter, or extended into a longer and more in-depth lesson.



WHAT TO DO

Download the image overleaf by following the **link**, and either display on a whiteboard or give children printed copies. Ask the children to work in groups of three to discuss the following questions:

What is happening in this picture?

Can you explain what is happening at each of the letters from A to O?

Other questions to generate and promote thinking and explaining

What might go wrong at each point?

What are the consequences of something going wrong?

Once the TV is on, can the person use the contraption to change the channel or switch it off again? What would they need to do first?

Talk to the children about what a machine is (a piece of equipment with moving parts that use power to do work) and that humans invent them to make work easier – can they think of any examples?

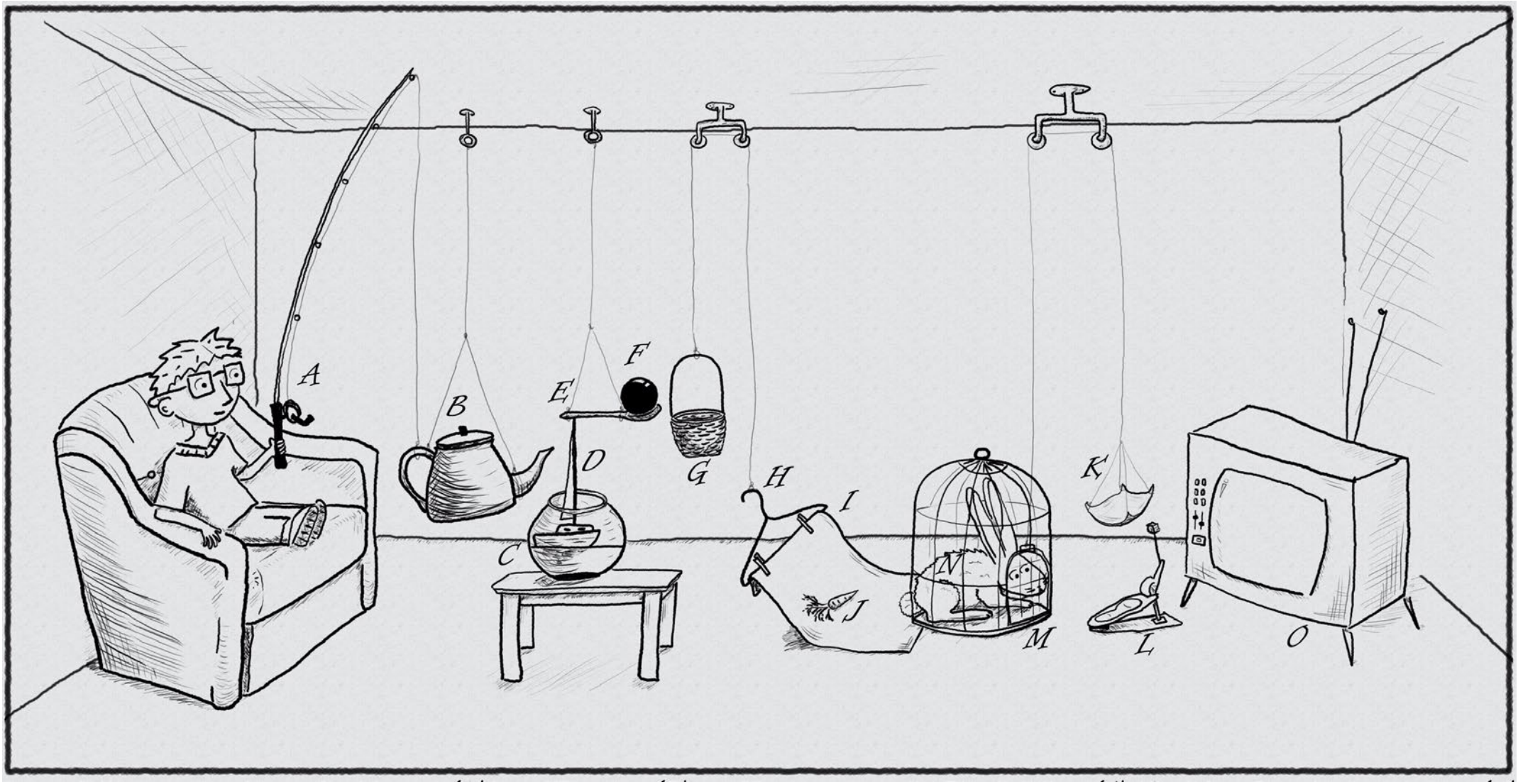
How many different machines are in the contraption in the picture?

Does this contraption make work easier for the person? Why/why not?

The picture can be used for a more focussed discussion about forces, levers and pulleys

How many examples of levers and pulleys can you find in the picture?

What can you say about the forces at points D and G?



CLICK TO DOWNLOAD IMAGE

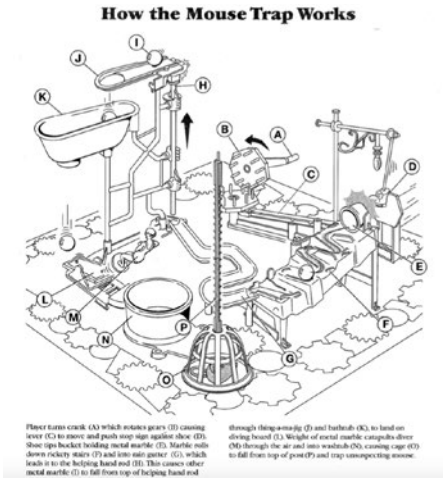
FREE RESOURCES

The Why and How Challenge

The 'Why and How' Challenge is intended to be something for the staffroom table that lots of teachers will try.
It is specifically designed to encourage the children to work scientifically to design and make something or to solve a problem.

This issue's Why and How Challenge is based on our **CHAIN REACTION** resource. You can download lots of supporting materials for this activity on the **PSTT website**. Could you run this as a **whole school competition?**

Have you ever played Mousetrap®?



As the game is played, a contraption is built, piece by piece. Eventually, one player will turn a crank handle, which sets the next piece (a gear) into motion, which triggers the next lever and so on, until finally, the trap itself falls on the mice.

Look at and follow the diagram, from part A through to O. The only part that the player moves is the first piece – the crank handle (A). After this, the pieces are arranged so they either move the next piece, or they trigger another object, such as a ball, a small diver or the trap itself to move.

Each of the parts must be positioned carefully to be sure that every single movement triggers another.

Mousetrap® is, of course, a commercial product, with each piece carefully manufactured so that it will always (or almost always) work. The mouse is trapped at the end of a mechanical chain reaction – by this we simply mean that by setting off the first part of a device, a whole series of movements will occur, each leading to another until the device finally stops with the planned outcome.

Such devices are sometimes known as 'Heath Robinson' or 'Rube Goldberg' devices. William Heath Robinson and Reuben Garrett 'Rube' Goldberg were both cartoonists/illustrators who drew designs for incredibly complicated machines that performed very simple tasks. You might like to look at some of their ideas online!

Some of our favourite Rube Goldberg devices can be found here:

coolmaterial.com/roundup/rube-goldberg-machines

There are also lots of really great examples on the Internet, which you will find if you search 'Rube Goldberg machine ideas for schools'.

WHAT TO DO

Design and build devices that create mechanical chain reactions. The device does not have to have a specific purpose, although you are more than welcome to set one. It certainly does not need to be as complicated as the amazing videos or pictures that you might find online, but feel free to develop your ideas in any way you wish!

You can use just about any ordinary, everyday objects that you choose, e.g. cardboard tubes, boxes, ramps, cups, toys such as marbles, balls, cars, dominoes etc. You could make parts from Lego® or K'nex® or use parts of larger toy sets such as marble runs or car tracks. Be creative!

Encourage children to work in small groups to create their devices in the classroom and provide plenty of time for everyone to watch them and describe the effects of the forces they see in action. Decide which device will represent the class or think about combining ideas.

Rules for devices:

- *You must be able to set up and run the device a number of times;*
- *The device must be portable –you may have to carry it around school and set it up again;*
- *There must be at least 4 different parts to the chain reaction;*
- *Once a device is set off, it should be able to run through to the end unaided.*

Here's how you could structure a whole school science challenge day:

Morning

Quick assembly to introduce the competition.

Children work in small groups to make a range of devices.

After break

Groups show their devices to the rest of the class and describe the effects of the forces.

Class decides on one device to represent the class.

Afternoon

Whole school to hall for the grand finale. Classes describe their device and demonstrate this to rest of school.

Panel of judges select winner based on own criteria e.g. most creative/ most effective machine.

FREE RESOURCES
From PSTT's own collection

PSTT are offering an exciting opportunity for **all children** to participate in a **climate change-based science project** in their school

Click **here** to register and download your free PSTT Climate Change Teachers' Project Pack

- Carry out a science project based on a climate change issue relevant to your local area
- All schools who sign up will receive a **free Climate Change Teachers' Project Pack**
- Further support available for schools throughout the project
- Open to all primary schools

Apply for your school to present their project at the PSTT Children's Conference at PSEC. Children from thirty primary schools will be invited to PSEC to present their work on Friday 7th June.

Selected projects will be presented by children on Friday 7th June at PSEC, giving delegates a wealth of inspiration for their own schools.

Find us on Facebook

/primaryscienceteachingtrust
Join our 'PSTT Children's Conference @ PSEC' group

@pstt_whyhow
#PSECchildrensconf

For more information and to register for your free Climate Change Teachers' Project Pack visit:

www.primaryscienceconference.org

I BET YOU DID'T KNOW...

How to clean water using a molecular sieve!

Prof. Dudley Shallcross, PSTT CEO, links **cutting edge research** with the **principles of primary science**

dudley.shallcross@pstt.org.uk

In many parts of the world, clean water is a major issue and drinking unclean water can lead to a wide range of illnesses and even death. Ironically, many people live near the sea but despite the closeness to water, it is undrinkable.

(Do our primary school children know this? Have they tasted salty water? Why is drinking salty water so bad for humans?)

There are many ways that water can be cleaned, and it would be ideal for children to try some of these in the classroom, but it turns out that removing salt from water is quite tricky. The salt is present as charged particles called ions and that makes it hard to remove. However, a simple idea is to use a sieve to remove the unwanted salt.

We can ask our primary school children how they might remove salt from seawater, and it would be interesting to hear their answers. Salt water could be left out in the sun or near a heater and eventually the water would evaporate leaving the salt behind, which is ok if you want the salt but not if you want the water. There are many potential opportunities for the children to explore questions surrounding changes of state here. Some specific questions that could be explored include: How does temperature affect the rate of evaporation? Does the amount of water or concentration of salt matter? Does salt dissolve in other liquids and can these be evaporated in the same way? Ideally, we want children to have as much chance to explore their own ideas as possible.

So how does a sieve work? We can demonstrate this (and experiment with this) with a normal sieve (or set of sieves) that we might use in cooking. We could try different mixtures of solids or solids and liquids and see if the sieve can separate them. If possible, set a challenge for children to form their own sieve simply from a sheet of paper, and use this to separate given mixtures of solids – this will help them to appreciate that sieves can be formed from many materials and that size matters.

We could try filter paper to see if that can separate out mixtures. The paper is also a sieve. What have the children discovered? Children should be able to explain that the size of the spaces in the sieve determine whether or not is it possible to separate the mixtures. In the case of salt and water, the materials available to them would make separation impossible. **Could we scale up any of these ideas so that they could make lots of fresh water from salt water or another water mixture?**

Scientists at the University of Manchester have taken a form of carbon called graphene and modified it so that it acts like a molecular sieve and can separate the salt particles (remember these are ions and have positive (sodium) and negative (chlorine) charges) from the water. Graphene is similar to the graphite that we find in a lead pencil. It is relatively cheap and could be a significant step forward in allowing the desalination (removal of salt from water) to take place.

What is graphene? These are sheets of carbon atoms that can be folded to make tubes and a wide range of other shapes. Hexagonal netting (such as chicken wire) is the perfect example of a model of graphene, but you could use jelly babies and cocktail sticks to make hexagons and stacking these will give the idea behind a molecular sieve (see Figures 1 and 2). The researchers have reacted the graphene with oxygen and made a graphene oxide layer. Their research shows if you can make the graphene oxide tubes with the correct size (i.e. make the right sized sieve) then the charged salt particles (sodium and chlorine ions) cannot pass through the graphene oxide layer, whilst the water can (Figure 3).

In the classroom, it would be possible for children to create models of this concept and use them to explain their understanding to others. Mesh bags (such as those in which oranges or marbles are purchased) or other mesh fabrics and bird netting, for example, are easily sourced. Can the children find appropriately-sized objects to represent the salt ions (this will vary, depending on the mesh of course)?

Although there is some way to go to make a workable pipe, the idea that you can flow salt water through a pipe made of this graphene oxide, and the salt is separated and removed so it becomes pure water is very exciting.

Can we make other structures with our models and discuss what applications these may have?

Figure 2: The structure of graphene resembles chicken wire

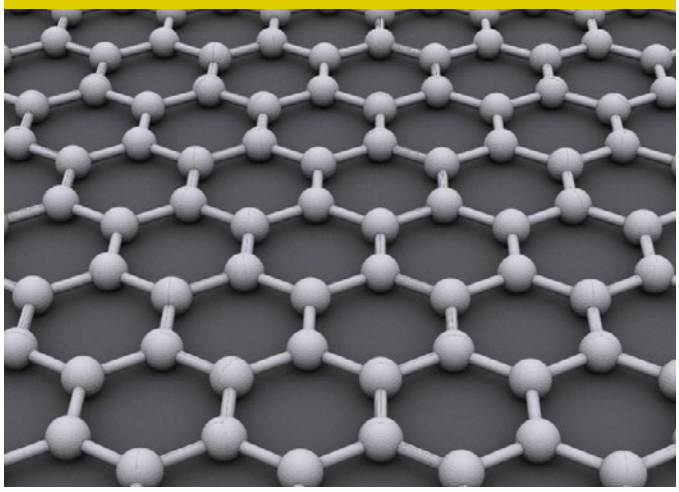
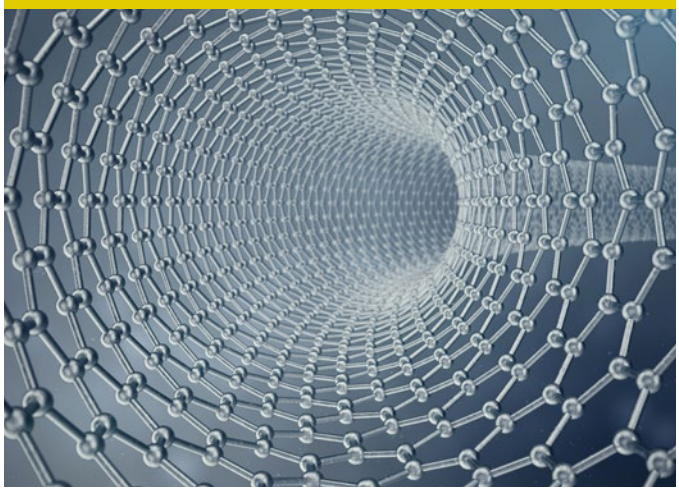


Figure 1: Modelling graphene in the classroom

Figure 3: Graphene can be shaped to form a tube



The research paper that generated this work was:

Tuneable sieving of ions using graphene oxide membranes

By: Jijo Abraham,[1,2,3] Kalangi S. Vasu,[1,2] Christopher D. Williams,[2] Kalon Gopinadham,[3] Yang Su,[1,2] Christie T. Cherian,[1,2] James Dix,[2] Eric Prestat,[4] Sarah J. Haigh,[4] Irina V. Grigorieva,[1] Paola Carbone,[2] Andre K. Geim[3] and Rahul R. Nair.[1,2]

Nature Nanotechnology, **vol. 12**, *pp. 546-551 (2017)*

[1]. National Graphene Institute, University of Manchester, Manchester M13 9PL, UK.

[2]. School of Chemical Engineering and Analytical Science, University of Manchester, Manchester M13 9PL, UK.

[3]. School of Physics and Astronomy, University of Manchester, Manchester M13 9PL, UK.

[4]. School of Materials, University of Manchester, Manchester M13 9PL, UK.

All the researchers are from the University of Manchester.

Discuss these questions with the children:

Why are there so many different people from different departments in the University working on this project? How did they manage to work together on this project?

PSTT COLLEGE SNAPSHOT

Meet six of our **College Fellows** who share some quick thoughts and suggestions for teaching primary science.

Katrina Halford

Somerset

Partnerships manager for an educational resource company, and science support teacher

Year of award: 2013

Favourite topic to teach in science?

It's the 'tricky' ones like rocks and evolution that I enjoy most - looking for ways to engage the children and get some practical application in too. Turning something that might be perceived as hard or worse... boring...into something that sparks and maintains the children's curiosity.

Best strategy for helping children develop independence in their science learning?

Avoiding lengthy written activities so that we can focus on the science learning and not be held back by writing ability. Reporting back in different ways such as video, audio recordings, drama all help boost confidence.

Most recommended book/website for supporting teaching in science:

For teachers to help with their subject knowledge and confidence I always recommend the **ReachOut CPD** site which is packed with accessible and manageable activities to develop confidence at any stage of a teacher's career, plus practical ideas that can be easily used in the classroom.

Maria McGrory

Sunderland

Current year group: Y2

Year of award: 2015

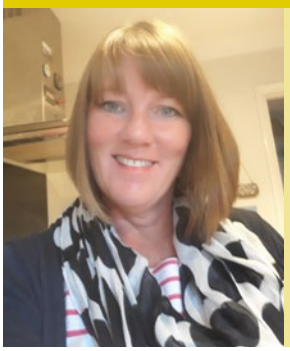
Favourite topic to teach in science?

Seasonal change as it gives so many opportunities to engage the children with the world around them and to notice things that are happening under their nose that they might otherwise have missed. It is great topic for children to learn to collect data and make comparisons.

Most used piece of equipment in your science cupboard?

Our microscopes get the most use across the curriculum. We use them all the time to look at materials, plants, foods, bacteria etc. Across all the topics there is always something that looks ordinary to the naked eye but under a microscope is amazing. One child, having said to her friend that grass was not interesting because it is all over the garden, looked at a piece under a microscope and called out, "Just you look at this! You'll be blown away! It's so so so special!"

Jo Fenton



The New Forest, Southampton

Current year group: Y6

Year of award: 2014

Best strategy for helping children develop independence in their science learning?

In the same way that we give small next steps in literacy, we do the same in science. Allowing children to try things, make mistakes and realise that it is okay is key. Also, I never have groups bigger than three... I don't let children hide!

Most used piece of equipment in your science cupboard?

My talk boxes are always out in class, allowing children to voice record when they have scientific moments of clarity and, occasionally, brilliance. They have transformed recording for my dyslexic pupils who are often spectacular scientists. We now have at least 10 in every classroom.

Jenni Monach

Sheffield

Y4 class teacher and Science Subject Leader, STEM learning Science Learning Partnership Primary Co-Lead

Year of award: 2012

Best strategy for helping children develop independence in their science learning?

I like to have a working wall in Science that grows with the topic, full of words and ideas children can use in their work. Teaching generic science skills is so important too – we can get hung up on knowledge.

Most used piece of equipment in your science cupboard?

Probably stopwatches. It's amazing how many things you can time and we are trying to cover the statistics side of maths in science using real data – then we can do science in our maths time too!

John Sandford

County Down, Northern Ireland

Current role: Vice Principal

Year of award: 2013

Most used piece of equipment in your science cupboard?

Shot glasses from the pound store! You can use them to test liquids, collect small objects, measure out dry ingredients and upturn them to observe a bug... They stay crystal clear and can be reused loads of times.

Most recommended book/website for supporting teaching in science?

Lesley Hunter's series of 'Here's my topic, where's my science' books are a great source of inspiration, as are **Paul Tyler's Topical Science updates**.

Bryony Turford

Yorkshire

Freelance primary science consultant, professional development champion with SEERIH at University of Manchester and Senior Regional Hub Leader with PSQM

Year of award: 2012

Most used piece of equipment in your science cupboard?

Playdoh! I use it for everything - changing materials with Year 2 and as a key part of a squishy circuit with Year 6 but also in less obvious ways: Show me how you know.... What do you think might happen when...? What do you already know about...? A teeny pot each at the start of the year is a must have for every child in my class.

Funniest thing you have heard a child say in a science lesson?

Not so much funny, more of a wonder that made me grin for weeks afterwards. Shortly after breaking the news to a Year 6 pupil they were in fact an animal, they asked... 'You know how humans can't see air, well, do you think fish can see water?'

RESEARCH UPDATE

John F. McCullagh and Andrea Doherty from Stranmillis University College, Belfast share a summary of their research

'Digital Makeover: What do pre-service teachers learn from microteaching primary science and how does an online video analysis tool enhance learning?'

As Academic Collaborators for the Primary Science Teaching Trust our research activity includes devising and evaluating effective pedagogies for science teacher education. It makes sense to ensure that from the very outset of their career newly qualified teachers are fully competent in teaching primary science and, equally important, confident and 'comfortable' in their science practice. The quality and quantity of science being taught in Northern Ireland primary schools, and thus the 'science experience' of student teachers during their placement, can vary greatly. Therefore one area of our research explores which college-based activities students feel best support them during their first experiences of teaching science and technology.

This paper reports on pre-service teachers' experiences of using the web-based video analysis tool VideoAnt during microteaching seminars in primary science. Data obtained from questionnaires and focus group interviews of 93 undergraduate students indicate that this online video analysis tool adds significant value to the learning resulting from each of the three characteristic features of microteaching; shortened lessons, video analysis and feedback. This tool allows students to time- mark particular incidents in their microteaching, add evaluative text, and share their analysis with peers and tutors.

email needed

This interactivity helps nurture a more forward looking disposition to evaluation and conceptualises reflection as a process of enquiry rather than merely a simple dichotomy of 'right' and 'wrong'. The findings show that this form of microteaching can provide a valuable preface to actual classroom experience and allow for professional growth within the safe and theory-rich context of a university college. The synchronizing of teacher action (as it appears in the video) and the explanatory comment (accompanying annotation) provide a priceless insight into the otherwise tacit thinking behind a pre-service teachers' practice. This allows for feedback and guidance which is no longer restricted to the observable enactment of practice and facilitates a discussion based on more theoretical issues.

The over-whelming majority of pre-service teachers enjoyed using the tool and reported that the experience had increased their levels of confidence in teaching primary science and that as a result they would now be better equipped to learn during the course of school placement. The findings may help address the challenge of achieving greater integration between the college-based and school-centred components of ITE programmes, and enhance pre-service teachers' capacity to learn about teaching through teaching.

The full paper: McCullagh, J., Doherty, A. (2018) 'Digital Makeover: What do pre-service teachers learn from microteaching primary science and how does an online video analysis tool enhance learning?' TEAN Journal, 10(2), pp. 15-28, can be obtained by contacting John.

Interested in finding out more? Please contact John by email:

TBC

RESEARCH UPDATE

The Journal of Emergent Science

'Reflections on and analysis of the use of drama techniques and dialogic practices in teaching science in primary school'

PSTT Fellow Clarysly Deller's paper examines science learning experienced in a primary school, in the light of theories of social constructivism and how they can illuminate and explain learning experienced within an innovative project. This project sought to combine the use of drama techniques to teach tricky concepts in science with discussion, collaboration and peer support. Having established the background to the project, the research presented examines some of the theories of social constructivism evidenced in the project, so as to promote similar approaches in the future. Its findings point to the usefulness of social collaboration in learning, the value of dialogic practices and the use of scaffolding to enhance and deepen scientific understanding.

Download the full paper here

Interested in finding out more? Please contact Clarysly by email:

c.deller@mmu.ac.uk

'Teachers' attempts to improve assessment practice in primary science are influenced by job role and teaching experience'

Isabel Hopwood-Stephens is a PSTT funded PhD student at Bath Spa University. In her paper she outlines how recent changes to assessment policy in England have brought the development of primary teachers' assessment literacy in science to the fore. The TAPS pyramid, developed by Bath Spa University and funded by PSTT, is used by teachers and schools as a tool to improve their assessment practice in primary science. It has been downloaded thousands of times across 45 countries, but little was known until now about its impact upon the actual assessment practice of the teachers using it. This report analyses quantitative data from an online survey of 96 teachers using the TAPS pyramid to show that changes in practice vary across job role and teaching experience. These differences are explored with reference to changes in national assessment policy, but also the wider international research into developing primary teachers' assessment literacy. Finally, an argument is made for school leaders to consider the diversity in assessment literacy present among their teachers when developing primary science assessment practice.

Download the full paper here

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Interested in finding out more? Please contact Isabel by email:

TBC

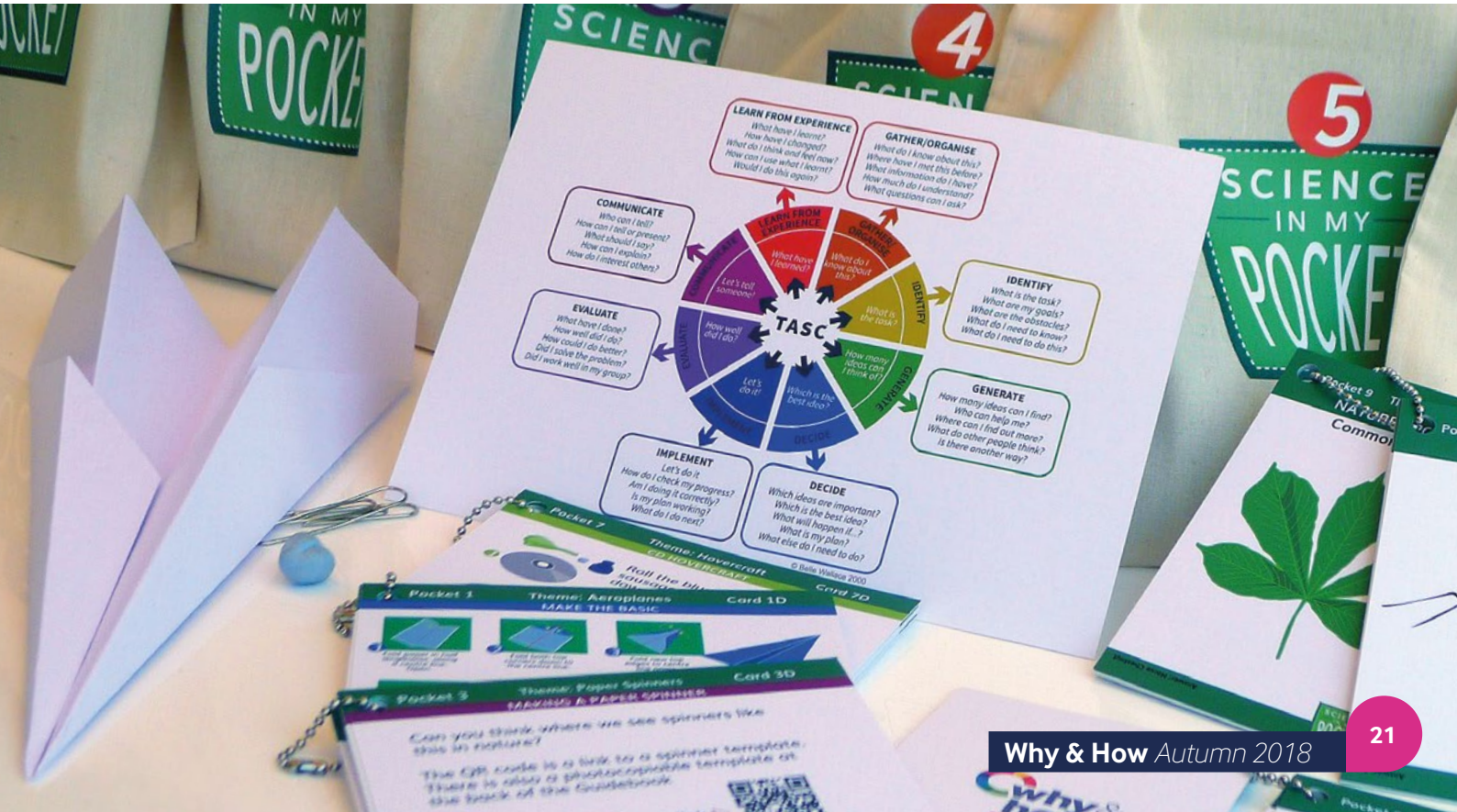
PROJECT UPDATE

Science In My Pocket

From its simple beginning as a magnet in a teaching assistant's pocket, the Science In My Pocket project has now grown into a comprehensive and invaluable resource for schools. The latest addition to PSTT's collection of resources, Science In My Pocket is an exciting set of structured science activities for teaching assistants to use with children who need emotional and behavioural support.

Schools have a critical role to play in supporting children's mental health and emotional wellbeing. One in ten school aged children in the UK – an average of three in every primary school classroom – have diagnosable mental health conditions, and three quarters of these children are not getting the support that they need.[1] Untreated mental health issues in children can have life-long consequences, yet sixty five percent of Headteachers report that they struggle to access mental health services for children in their schools.[2] The classroom can be a challenging place for these children and it often falls to a Teaching Assistant to supervise them and support their learning on a one-to-one or small group basis.

Outcomes of the trial of Science In My Pocket show that carefully designed, simple science activities can help children with these difficulties to learn to self-regulate their emotions and behaviour. The activities provide a temporary outlet or distraction for the child, enabling them to return to a whole class setting more ready to learn and participate. The activities also develop social skills as they present a context for the child to communicate positively with their peers.



Science In My Pocket is a welcome addition to a teaching assistant's toolkit. More than just a set of activities, it offers a whole new way of working and increases the confidence of teaching assistants to engage children in scientific discussion. Its principles can be applied to other curriculum areas, particularly maths.

Science In My Pocket generates independent thinking and gives the children a sense of purpose about what they are doing. The activities support Teaching Assistants to prioritise the development of the children's determination and resilience, and to encourage them to take responsibility for making decisions about what to do next.

What teaching assistants say about Science In My Pocket

"*Science in My Pocket has given me so much more confidence to do science with children.*"

"*The whole Teaching Assistant team are looking forward to using this resource.*"

"*Using Science In My Pocket has made me think more about what happens to a child when they are removed from the class.*"

What children say about Science In My Pocket

"It was fun going round the school and going to different places."

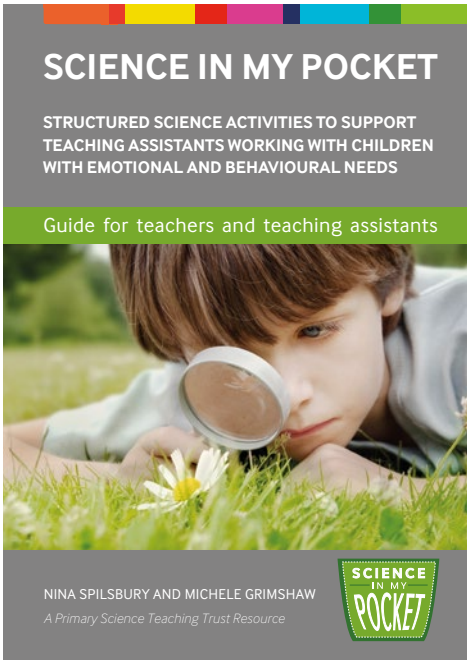
"I loved checking whether things were magnetic."

"It was so nice as I got to show everyone what I did and they all liked it."

Science In My Pocket was created by PSTT College Fellows Nina Splisbury and Michele Grimshaw. The pack consists of:

- *Ten cloth drawstring 'pockets' each containing instruction cards for a series of investigative science activities based around a particular theme. NB The rest of the equipment that needs to be added to the bag is listed but not supplied)*
- *A teachers' guide, including additional photocopiable resources*
- *An A3 poster to support schools with how to organise using the resources*

If you would like to be notified when it is available, please join our **mailing list**.



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1. *Young Minds (2016) Impact Report: youngminds.org.uk/media/1240/ym-impact-report-2015-2016.pdf*
2. *Association of School and College Leaders (2016): www.ascl.org.uk/news-and-views/news_news-detail.school-leaders-voice-concernsover-children-s-mental-health-care*

PROJECT UPDATE

The role of 'Storyness' to develop thinking capabilities in science

Sally Howard shares some of her research, ideas and experience of the role of stories in developing scientific thinking and enquiry.

> *"As a house is not a pile of bricks, so science is not a pile of disconnected facts"*
>
> *Harlen, 2010*

Science education should not just be the transmission of information but an enriching process where imagining, reasoning and cognitive growth blossoms, with colour and texture being added by the child's mind. Through a language rich environment, a dialogic relationship between adult and child (Alexander, 2008) can scaffold a child's emerging understanding of the 'big ideas' in science (Harlen, 2010).

Using language as a tool for learning is not a new idea but what might not be so well known is that the actual process of reading and writing stories stimulates a range of important neural systems (Geake, 2009) and that narrative structures help to shape our beliefs and behaviours (Gottschall, 2012).

The very act of reading a story requires the brain to decode and encode the visual symbol system while the auditory system must simultaneously match the sound to the internal systems. In the same way listening to stories (from any genre) involves these identical neural connections, and this leads to sense making. Recognition that these processes are the same in reading and in hearing provides a rationale for stories having a higher profile in primary and secondary schools; they play an important role in developing higher order thinking capabilities in children, and these are needed for scientific inquiry.

There are broadly three types of story books useful to science education. The first two outlined below will be familiar, although it is the third category that I wish to describe in greater detail:

1) Books that have the science as 'possibilities' and provide a context for further scientific exploration

- 'The Rescue Party' by Nick Butterworth – provides a hook to explore 'forces' such as pulleys, levers and friction from a very basic approach to more complex levels of scientific enquiry.

2) Specially written books which explore science themes and raise scientific explorations

- 'Out and About Through The Year' by Shirley Hughes – a collection of poems about the seasons.
- 'Dinosaurs And All That Rubbish' by Michael Foreman – explores issues around recycling and conservation.
- 'The Hungry Caterpillar' by Eric Carle – looks at the life cycle of a butterfly.
- 'The Seesaw and Other Science Questions' (Millgate publishing) and 'I Wonder Why. Questions and Answers about Science and Technology' (published by Kingfisher) – these utilise a range of genres, including simple story structure to provide scientific information.

3) Books where the story narrative is used to captivate and intrigue the reader to 'solve' the dramatic incident and understand the problem from an alternative perspective.

- 'Heckedy Peg' by Audrey Wood – full of detailed illustrations and short text and builds up suspense yet enables the reader to identify the likelihood of different outcomes using narrative seriation.
- 'The Moon's Revenge' by Joan Aiken and Alan Lee – an engaging and magical narrative, achieved using vivid, yet mysterious pictures that go beyond what is written. The story promotes logical deduction and stimulates the imagination and thinking processes beyond the readers' actual experiences. The relationship with these types of story books and 'science' is that the process of thinking required to unlock the plot and paint the characters are the same as the thinking capabilities that professional scientists draw on when working scientifically.

The story structure in this third category of books crosses cultures and time and has been part of 'teaching' for centuries, e.g. Greek legends, fairy tales and fables. These stories tend to share familiar structures such as, 'Once upon a time' or 'Long, long ago' and it is by predicting what comes next that probability theory is being drawn on in an unconscious way, even in very young children. The same principles of anticipation and problem solving also apply to other genres such as thriller, love story or horror as it is the predictability of the structure that leads to the important reasoning processes of hypothesising, evidence checking and conclusion. Stories engage the brain in problem solving, decision making and learning the rules of the world. The more absorbed a reader is in a story, the more it is likely to change their thinking and their behaviours. The retelling or reading stories and jokes involves the creation of new connections in the brain. This stimulation of complex neural systems through rich 'storyness' helps develop higher order thinking capabilities such as causality, seriation, probability and deductive reasoning, all of which are important aspects of thinking like a scientist.

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Geake, J. G. (2009) The Brain School. Educational Neuroscience in the Classroom. McGraw Hill

Gottschall, J. (2012) The Storytelling Animal: How Stories Make Us Human. Houghton Mifflin Harcourt. New York.

Harlen, W. (2010) Principles and Big Ideas of Science Education. Association for Science Education.

Find out more about using stories in science by looking at the puppets and stories CPD unit on our website.

Sally Howard is a PhD student at Oxford Brookes University. Her PhD is jointly funded by the University and the Primary Science Teaching Trust. Interested in finding out more? Please contact Sally by email:

sally2how@yahoo.com

Key Dates

ASE Annual Conference

9th – 12th January 2019

University of Birmingham

Programme includes over 450 sessions from early years to ITE

British Science Week

8th – 17th March 2019

@ScienceWeekUK

#BSW19

PSTT's international Primary Science Education Conference (PSEC)

6th – 8th June 2019

Edinburgh International Conference Centre (EICC)

Save the date and join us in Edinburgh for our international Primary Science Education Conference (PSEC)!

We are determined that there should be no barriers to every child receiving an outstanding education in primary science, and we are committed to our vision that teachers are the key to making this happen. Through crossing boundaries between the classroom and academia, between policy and practice, and between one nation and another, our conference in 2019 will empower educators to develop excellence in primary science.

Manchester University Great Science Share for Schools

18th June 2019

University of Manchester #GreatSciShare

In 2018 the Great Science Share for Schools engaged over 40,000 young people in sharing their science learning with new audiences. Don't miss joining in with this national campaign on 18th June 2019. For more details visit: www.greatscienceshare.org

The Big Bang

13th – 16th March 2019

Birmingham NEC